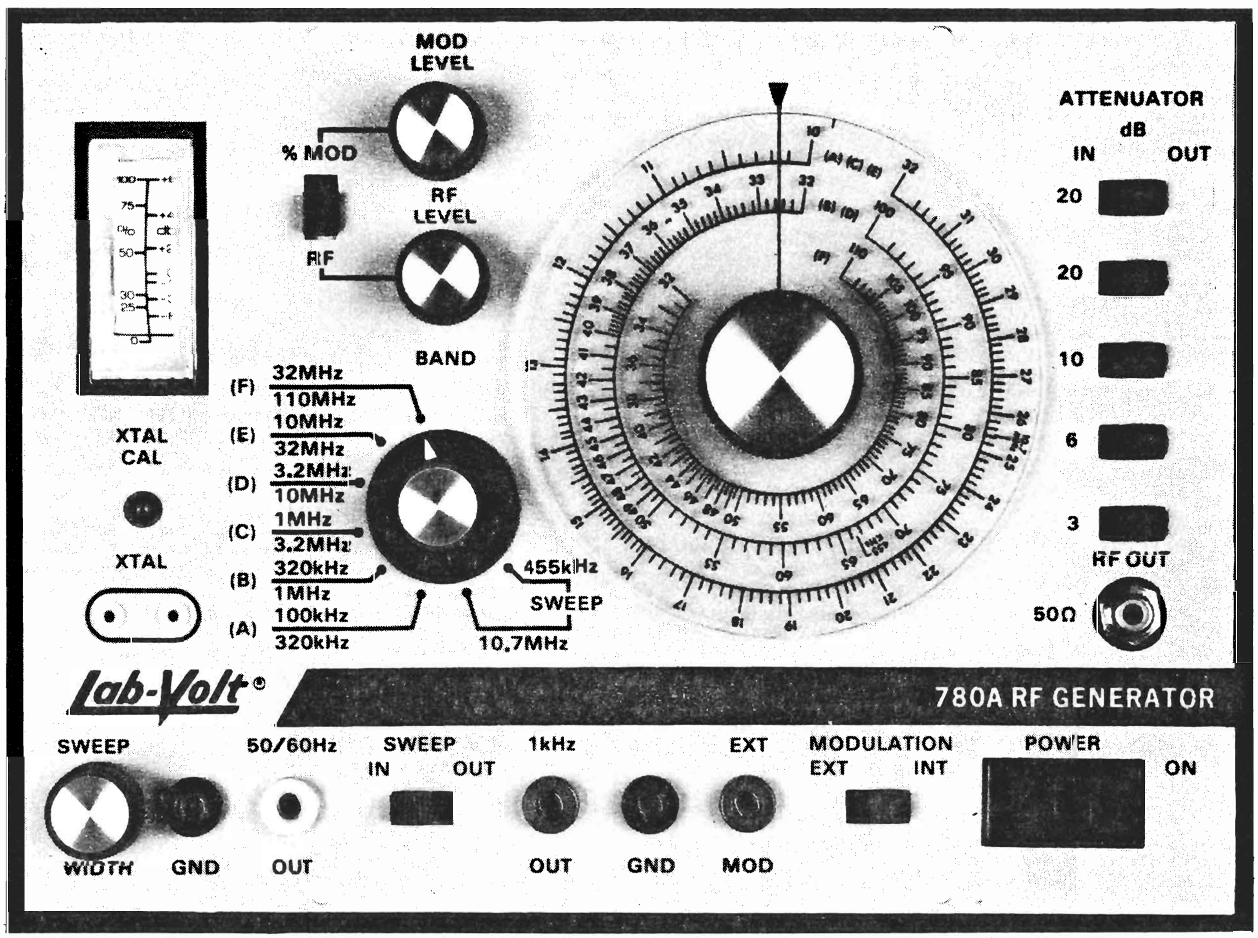
RF GENERATOR INSTRUCTION MANUAL



MODEL 780A/980A

INTRODUCTION

The RF Generator Models 780A/980A are manufactured and tested under strict quality control. If the instrument is within the warranty period and requires repair or adjustment, contact your field representative to obtain instructions for forwarding the model to the nearest authorized Lab-Volt repair station.

If the instrument is beyond the warranty period, and repairs are necessary, it is still recommended that it be returned for service. Special equipment of high accuracy is needed to calibrate this instrument. Test equipment should have accuracies ten times greater than the required accuracy of adjustment. However, if it becomes necessary to replace any of the component parts, only Lab-Volt replacement parts or their equivalent should be used. Order parts through your Lab-Volt field representative.

This manual contains a schematic diagram and an itemized parts list.

This manual contains information for the AA (115V, 50/60Hz) and the AE (230V, 50/60 Hz) versions of Model 780A/980A RF Generator. Differences between the two versions are noted.

Tenth Printing, June 1998

Printed in the United States of America

WARRANTY

Lab-Volt Systems, Inc. warrants all Lab-Volt equipment against defects in materials and workmanship for a period of one year from the date of installation and/or acceptance by the customer. This warranty covers only the intended use of the equipment and does not cover damage due to alteration, negligent use, or normal wear.

We assume no liability for damage, injury or expense claimed to have been incurred through the installation or use of our products.

Questions concerning this warranty and all requests for repairs should be directed to the Lab-Volt Systems, Inc. field representative in your area.

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RF GENERATOR

MODELS 780A/980A

CONTENTS

SECTION 1

GENERAL DESCRIPTION

The Model 780A and 980A RF Generators are a solid state, fully protected, general purpose RF generator. The frequency coverage and operating characteristics are designed to meet the requirements of engineering laboratories, educational laboratories, production test facilities and consumer product repair shops. It is an ideal instrument for testing AM and FM transmitters and receivers.

The Models 780A and 980A are designed for maximum utilization. The operating frequency range of 100kHz to 110MHz is divided into six switch selected bands plus two sweep frequencies. A calibrated circular dial provides the means of tuning the desired frequency within each band. The continuous wave RF output impedance is a constant 50 ohms over the entire frequency range. Any desired output signal level from 0 to -59db, ±6db, can be established using a five step attenuator and a variable level control. The RF signal from 100kHz to 32MHz can be amplitude modulated from 0 to 100% internally at 1kHz, or externally to 15kHz. A switch selected dual function meter is used to set the RF output level to ±6db in conjunction with the variable level control, and to measure the percent of modulation applied to the signal. The two sweep frequency signals, centered at 455kHz and 10.7MHz and swept at a 50/60Hz rate, provide a convenient source of alignment signals for the IF strips in AM and FM receivers. The sweep signal can be removed from either of these two signals to obtain fixed outputs of 455kHz and 10.7MHz. In addition to these features, the RF Generator contains a crystal oscillator, activated by an external plug-in crystal, with a frequency range of 100kHz to 15MHz. The crystal oscillator can be used in conjunction with a crystal calibrator having a visual (LED) indication of zero beat to calibrate the RF output frequency. For synchronization and test purposes, the 50/60Hz sweep rate signal and the 1kHz modulation signal are also brought out to separate output terminals.

Accessories Available Separately

NOTE: **The crystals listed below are in stock, but must be ordered separately. Other crystals with frequencies from 100kHz to 15MHz may be obtained by special order. Order through your local Lab-Volt Representative.**

Frequency	Stock Number
100kHz	LU 14587-01
455kHz	LU 14587-02
10.7MHz	LU 14587-03

SECTION 2

SAFETY

Electrical shock is a hazard we all face every time we work in or around sources of electrical power. While it is generally true that knowledge and experience tend to reduce the danger, it should be borne in mind that electrical current does not pause to inquire into one's qualifications before shocking him and even the most sophisticated engineers and technicians will profit by periodically reviewing the following basic safety precepts.

1. Avoid using the RF Generator while it is out of its enclosure.
2. When connecting leads from the RF Generator to exposed circuits, make sure circuit power is turned off.
3. Periodically check your work area for potentially hazardous conditions. Don't let clutter creep up on you. Place a rubber mat or similar insulating material over the floor area in front of your bench. A non-conductive work surface reduces the possibility of shock.
4. Beware of broken or cracked insulation on power leads. Don't work with test leads whose insulated probe housings are damaged or missing.

5. Make it a point to handle test leads only by their insulated housings.

6. When making voltage measurements use one hand only and keep the other hand well away from the test chassis, preferably behind the back or in a pocket.

7. Always make it a point to have someone available to shut off power and render first aid in the event of an accident while working on live circuits.

8. Above all, bear in mind that a shock, in itself, may be the *least* dangerous of the hazards you face. Even a minor shock can cause such violent muscular reactions that a person could literally hurl himself against walls, work bench corners, racks and similar barriers. The resulting injuries can be far more disabling than the initial shock. It is also highly probable that muscular reaction to shock may force a person into contact with a lethal power source.

SECTION 3
SPECIFICATIONS

Frequency Range	Six Bands: (A) 100kHz to 320kHz (B) 320kHz to 1MHz (C) 1MHz to 3.2MHz (D) 3.2MHz to 10MHz (E) 10MHz to 32MHz (F) 32MHz to 110MHz
Dial Calibration Accuracy	Within ±3% of dial setting.
Attenuation (0db = 0.1V rms into 50Ω)	
Fixed	Five step attenuators: 20db, 20db, 10db, 6db, 3db.
Variable	RF level control
RF Output	
Maximum (center band)	Bands (A) through (F): 0.2V rms minimum into 50Ω.
Minimum (center band, 59db fixed and 6db variable attenuation)	Bands (A) through (E): 56.3μV rms into 50Ω.
Output Impedance	50Ω
Output Flatness (from center band)	Bands (A) through (E): ±3db Band (F): ±6db to 100MHz.
Sweep Output	455kHz center frequency; sweep width variable from approximately 5kHz to 21kHz. 10.7MHz center frequency; sweep width variable from approximately 100kHz to 600kHz.
Modulation (amplitude)	Variable to 100% from 100kHz to 32MHz. a) Internal at 1kHz b) External to 15kHz with input impedance of 8kΩ. Requires 2.8V rms max for 100% modulation.
Fixed Frequency Outputs	1kHz adjustable to 2.5V rms at 1kΩ output impedance. 50/60Hz line frequency at 7V rms (fixed).

Crystal Calibrator	Calibration points at fundamental and harmonics of external plug-in crystal; LED zero beat indicator. Accuracy ±0.1% or better.
Meter	
Modulation	0 to 100%; accuracy ±10% to 75% modulation.
RF Output	-6db to +6db; factory adjusted for 0db (0.1V rms) at 660kHz. Meter and switch attenuators accurate to ±1.5dB of calibrated output up to 32MHz.
Protection	Front panel input and outputs protected against short circuit conditions. All Lab-Volt equipment is protected against inadvertent connections between terminals.
Input Power	105/125Vac or 210/250Vac, 50/60Hz, 12W
Ambient Operating Temperature	0 to 50°C
Overall Dimensions Without Enclosure	
780A	7.00″ high X 9.50″ wide X 6.00″ deep.
980A	9.00″ high X 6.25″ wide X 6.00″ deep.

The Model 780A chassis is fabricated from heavy gauge steel, employs welded construction and is finished with a durable, scratch resistant beige paint. It can be housed in the Model 750/751 modular system enclosure or the Model 756 portable enclosure. The Model 980A is similar in construction except for size and finish. It can be housed in the Model 900/901 modular system enclosure or Model 911 portable enclosure.

SECTION 4

OPERATING INSTRUCTIONS

1. OPERATING CONTROLS AND INDICATORS (Refer to *Fig. 1*)

a) Meter M1 (1). This 100mV, 10 ohm, 3% of full scale meter movement has a split, edge-reading, scale and is used in conjunction with the %MOD/RF switch (2). The left side of the scale is calibrated in increments from 0 to 100% and indicates the percent of amplitude modulation applied to the RF output signal. The right side of the scale is calibrated in increments from -6db to +6db and indicates the level from 0db of the RF output signal when the output is terminated in a 50 ohm load.

b) BAND switch A1A1S1 (2). The BAND switch selects one of six bands for the desired output frequency and one of two sweep frequency ranges. The legend identifying each band is keyed to the three frequency scales marked on the RF Frequency dial (6); the sweep frequency points are also marked on the dial.

c) RF LEVEL control A1R1 (3). This control varies the amplitude level of the RF output signal plus or minus 6db from 0db, or the value set on the step ATTENUATOR (7).

d) MOD LEVEL control R1 (4). This control varies the level of the internal amplitude modulation of the RF carrier from 0 to 100%. It also adjusts the 1kHz output signal available at the 1KHz OUT jack (14) from 0 to approximately 8 volts peak-to-peak.

e) RF Frequency dial A1C1 (5). The main tuning dial rotates the tuning capacitor and indicates the output frequency. The three frequency scales are keyed to the six frequency bands and two sweep frequencies selected by the BAND switch (5). Thus, if the desired frequency is 500kHz, the BAND switch is set to band B (320kHz-1MHz) and the dial is rotated until 50 on the center scale is positioned over the index.

f) POWER switch S1 (6). This rocker-type switch connects and disconnects line voltage to the power supply to turn the unit on and off. Switch illuminates to indicate that primary line voltage is applied to the RF generator.

g) EXT MOD jack J1 (7). External modulation signals are applied to this red banana jack, which is connected into the modulation circuit when the MODULATION switch (11) is in EXT position.

h) ATTENUATOR db switches A2S1-A2S5 (8). These five slide switches introduce various levels of fixed attenuation from 0 to 59db in series with the RF output signal. The five individual steps are: 20, 20, 10, 6 and 3db. The IN positions add attenuation and the OUT positions remove attenuation.

i) GND jack J2 (9). Black banana jack which serves as a ground lead connection for the 1KHz OUT jack (10) and the EXT MOD jack (7).

j) 1KHz OUT jack J3 (10). The internal 1kHz oscillator signal is supplied to this red banana jack when the MODULATION switch (18) is in the INT position. The amplitude of the 1kHz output is variable between 0 and approximately 8 volts peak-to-peak using the MOD LEVEL control (4).

k) RF OUT 50Ω jack A2J1 (11). The RF output signal is taken from this terminal. A shielded 50Ω cable with a phono plug is supplied for use with this terminal.

l) 50/60Hz OUT jack J4 (12). The 50/60Hz sweep rate signal is available at this yellow banana jack at an amplitude of 7 volts rms.

m) SWEEP WIDTH CONTROL R9 (13). This control varies the amount of frequency variation above and below the center sweep frequencies of 455kHz and 10.7MHz.

n) GND jack J5 (14). Black banana jack which serves as a ground lead connection for the 50/60Hz OUT jack (12).

o) XTAL socket (15). This two pin crystal socket accepts the external plug-in crystal. Inserting the crystal activates the crystal oscillator.

p) XTAL CAL indicator DS2 (16). This red light emitting diode (LED) provides a visual zero beat indication for the crystal calibration procedure.

q) SWEEP switch S3 (17). When the BAND switch (2) is set to one of the two sweep frequency positions and the RF frequency dial (5) is set to the sweep center frequency, this switch must be set to the IN position to apply a 50/60Hz sweep voltage to the RF carrier signal to produce a sweep output. The OUT position removes the sweep voltage.

r) MODULATION switch S1 (18). This switch selects internal or external modulation. When the switch is in the INT position, the RF carrier is modulated by the internal 1kHz oscillator. When the switch is in the EXT position, the RF carrier can be modulated by any suitable external source up to 15kHz. This switch determines whether the 1KHz OUT jack (14) or the EXT MOD jack (12) is connected into the circuit.

s) %MOD/RF switch S4 (19). Selects the measurement function of Meter M1 (1). The %MOD position connects the meter to measure the percentage of amplitude modulation of the RF output signal. The RF position connects the meter to measure the RF output signal level in db relative to 0db.

2. OPERATING INFORMATION

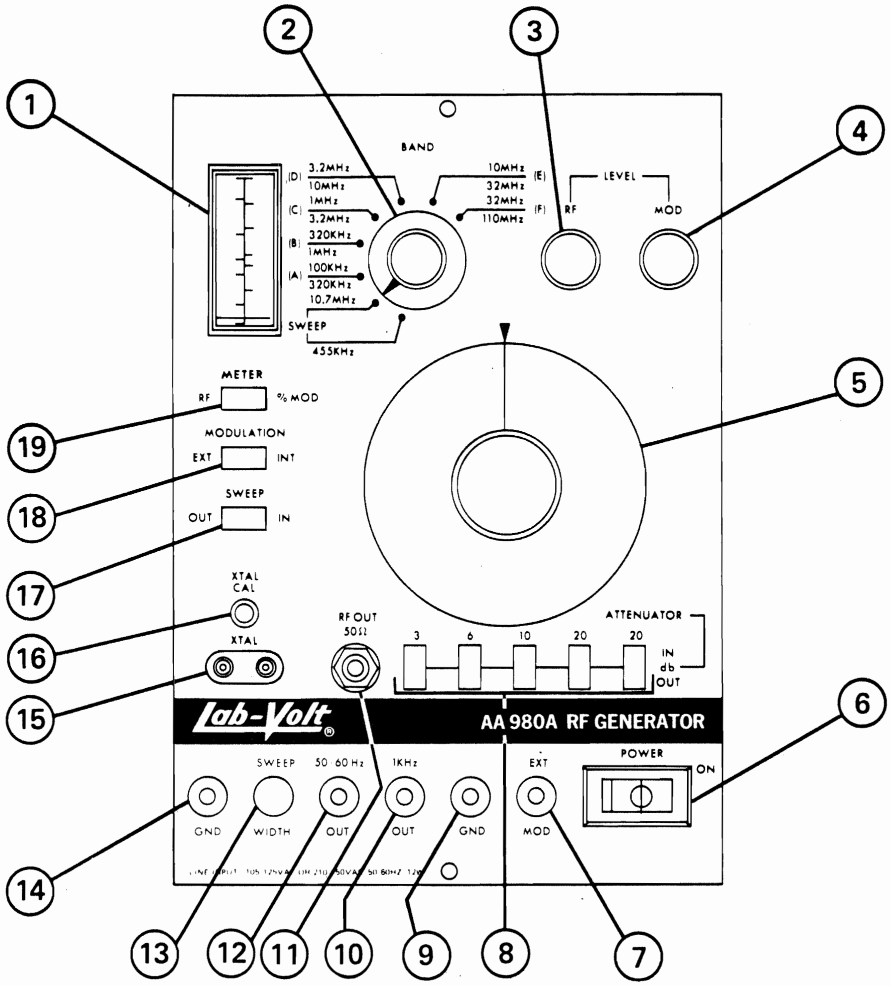
a) General.

1) Turn on power by depressing the right side of the POWER switch. Check that the red POWER indicator comes on. Allow a few minutes for warmup.

2) Rotate the BAND switch to the desired frequency range.

3) Rotate the RF frequency dial control knob until the desired frequency setting is positioned over the panel index line.

4) Connect the RF cable to the RF OUT jack. If the RF signal is to be applied to a circuit having an input impedance other than 50 ohms, an external 50 ohm termination resistor must be placed across (in parallel with) the open ends of the cable leads.



(Nomenclature for controls and jacks is identical for Models 780A and 980A. Control position for Model 780A will vary from that shown in this figure.)

Fig. 1 Front Panel, Controls and Indicators

5) Connect the RF cable leads to the equipment being tested. First, connect the black (ground) lead to the chassis, then the red (signal) lead to the signal injection point.

b) Setting The Signal Level.

1) Be sure the RF output cable is terminated in a 50 ohm load.

2) Set the MODULATION switch to the EXT position (no modulation).

3) Check that the BAND switch and RF Frequency dial are set for the desired frequency.

4) Set the %MOD/RF switch to the RF position.

5) Refer to *Fig. 2*. Determine the amount of attenuation in decibels required to produce the desired output signal level. The output level may be in millivolts, microvolts etc., but must be converted to db to correspond with the RF Generator controls. **(NOTE: 0db = 100mV in this unit.)**

6) Set as many ATTENUATOR switches to the IN position as necessary to come within the maximum db attenuation required. All other ATTENUATOR switches must be in the OUT position. Rotate the RF LEVEL control for any additional attenuation required as indicated on the db scale of the Meter. The total attenuation is equal to all the ATTENUATOR switches in the IN position plus the Meter reading below the 0db reference level. Levels above the 0db (100mV) reference can be obtained by placing all the ATTENUATOR switches in the OUT position and adjusting the RF LEVEL control for the desired level above the 0db mark on the Meter.

7) If greater accuracy is required in setting the output signal level, rotate the RF LEVEL control for a 0db indication on the Meter first, then set the required ATTENUATOR switches to the IN position. Readjust the RF LEVEL control for a 0db Meter indication each time an ATTENUATOR switch position is changed.

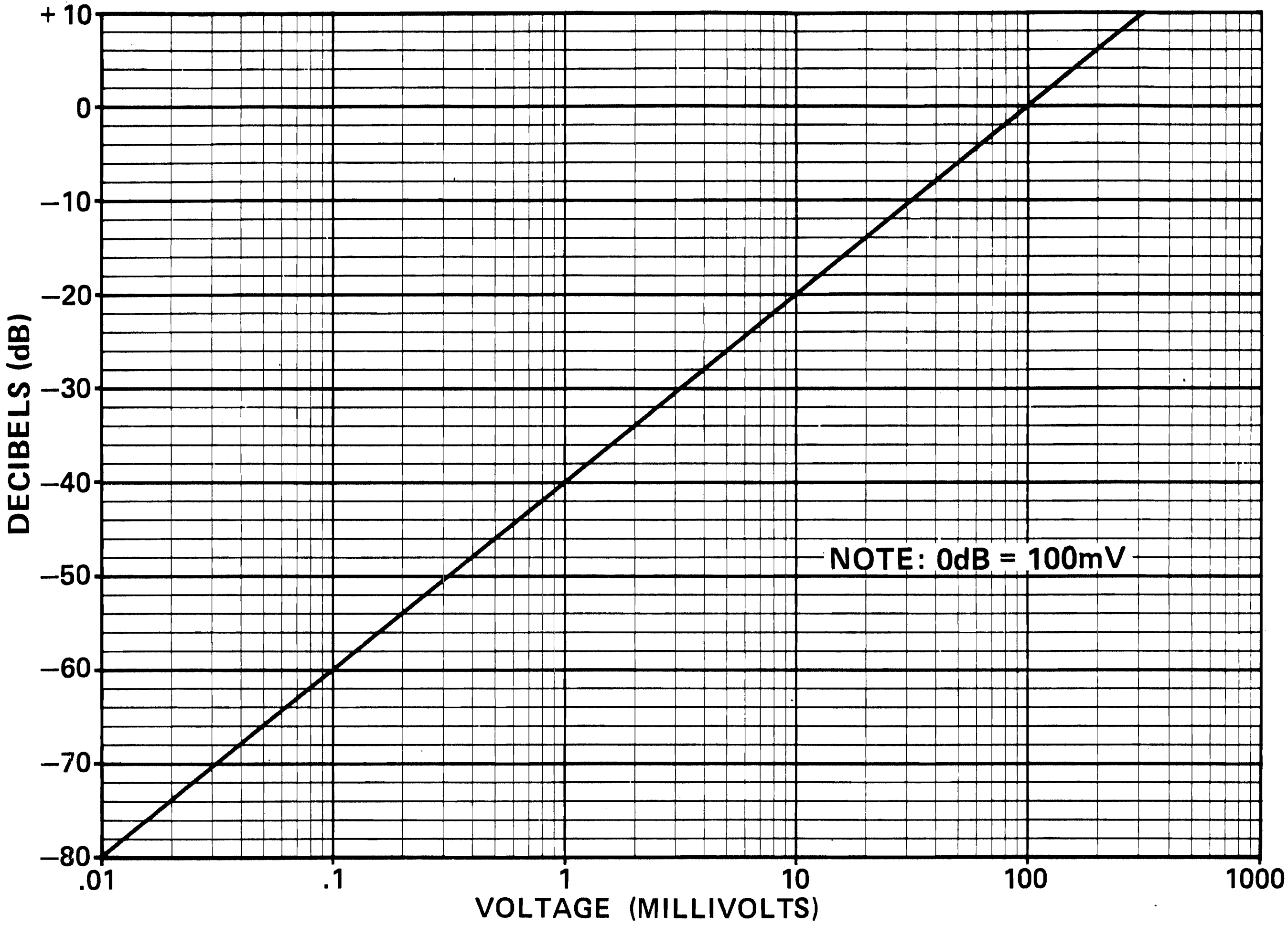


Fig. 2 Voltage To Decibel Conversion Chart

NOTE: **If the RF output is not terminated in 50 ohms, the output signal level is not calibrated. However, relative indications of higher or lower levels are still provided by the Meter and ATTENUATOR switches.**

8) As an example, assume the desired output signal level is 5 millivolts. From *Fig. 2* this corresponds to -26db. Set either (but not both) of the 20db plus the 6db ATTENUATOR switches to the IN positions. Rotate the RF LEVEL control for a 0db indication on the Meter.

c) Modulation.

1) Set the %MOD/RF switch to the %MOD position.

2) If the 1kHz internal modulation signal is to be used, set the MODULATION switch to the INT position and adjust the MOD LEVEL control for the desired percentage of modulation as indicated on the Meter.

3) For external modulation, set the MODULATION switch to the EXT position and apply the audio modulating signal (to 15kHz) between the EXT MOD and GND jacks. Adjust the amplitude of the external modulating signal for the desired percentage of modulation on the Meter. **(NOTE: The MOD LEVEL control is inoperable for external modulation.)**

d) Crystal Calibration. The crystal calibrator uses the zero beat method to calibrate the RF output signal of the generator. The XTAL CAL indicator is used as a zero beat indicator. The crystal oscillator signal is beat with the RF output signal to obtain a difference frequency. When the difference frequency becomes less than a few hundred cycles the XTAL CAL indicator lights. If both signals have the same frequency (no difference frequency), a zero beat occurs and the XTAL CAL indicator extinguishes. On either side of the zero beat, a small difference signal is produced and the XTAL CAL indicator will light. This results for only small difference frequencies, however, and the true zero beat is when the indicator extinguishes. Because of resolution limitations at the higher frequencies the true zero beat may not be distinguishable on

the indicator. In this case the maximum brightness indication must be used as the zero beat indication. This represents a calibration accuracy within ±0.1%, which is acceptable in most applications. Calibration points are at the fundamental frequency and harmonics of the external plug-in crystal.

1) Set the MODULATION switch to EXT (no modulation).

2) Set the SWEEP switch to OUT.

3) Select the desired frequency range with the BAND switch.

4) Rotate the RF Frequency dial to the desired frequency.

5) Set the RF output level as in paragraph 2b) before crystal calibrating the frequency. A slight frequency pulling can occur if the RF LEVEL and ATTENUATOR settings are changed during frequency calibration.

6) Plug the selected crystal into the XTAL socket.

7) Carefully adjust the RF Frequency dial until the XTAL CAL indicator lights, extinguishes and then lights again. Tune the dial for the null (extinguished) point between the two illumination points of the indicator. If the null point is indistinguishable, tune the dial for maximum brightness on the indicator.

8) Remove the crystal from the XTAL socket.

e) Sweep Frequency Crystal Calibration.

1) Set the MODULATION switch to EXT.

2) Set the SWEEP switch to OUT.

3) Rotate the BAND switch to the desired sweep frequency position (455kHz or 10.7MHz).

4) Rotate the RF Frequency dial to the sweep frequency setting that corresponds to the selected BAND switch position. The 455kHz and 10.7MHz points are identified on the dial.

5) Set the RF output level as in paragraph 2b).

6) Perform steps 6, 7 and 8 of paragraph 2d).

7) Set the SWEEP switch to IN to obtain the desired sweep frequency output.

SECTION 5

THEORY OF OPERATION

Refer to the schematic diagram of the RF Generator shown in *Fig. 8* for the circuits described in the following paragraphs.

1. RF OSCILLATOR CIRCUIT

The RF oscillator circuit uses a differential amplifier that forms a part of IC transistor arrays A1A1U1 and A1A1U2. The differential amplifier is comprised of transistors A1A1U1C and A1A1U1D. Transistor A1A1U2C, along with associated bias networks, serves as a current source. The frequency determining tuned circuit consists of coils A1A1L1 through A1A1L8 and variable capacitor A1C1 (tuning dial). Positive feedback is applied directly from the tuned circuit connected at the collector of A1A1U1D to the base of transistor A1A1U1C. The BAND selector switch performs four functions: (1) section A1A1S1A switches in the two sweep ranges (L1 and L2), (2) section A1A1S1C switches in the six frequency ranges (L3-L8), (3) section A1A1S1B shorts out all coils (A1A1L1 through A1A1L8), except the one coil being used, to prevent interaction between coils, and (4) section A1A1S1D selects the proper bias network for A1A1U2C. Trimmer capacitors A1A1C1 through A1A1C6, in conjunction with the tuning slugs in the coils, provide a means for fine frequency adjustment during calibration or touch up. Amplitude adjustment is made available on bands (A) through (F) by potentiometers A1A1R30, A1A1R34, A1A1R28, A1A1R26, A1A1R32 and A1A1R24, respectively.

The RF oscillator is amplitude modulated by varying the gain of the differential amplifier. The modulating signal is applied through potentiometer A1A2R39 and capacitor A1A2C22 to the base of transistor A1A1U2C. The input signal is converted to a current by transistor A1A1U2C and the various emitter networks, and is then divided through transistors A1A1U1C and A1A1U1D. The peak voltage gain of the differential amplifier RF oscillator circuit is equal to the emitter current of transistor A1A1U2C times the parallel impedance of the tuned circuit at resonance. Therefore, by changing the emitter current with a varying modulating voltage, the gain will vary accordingly.

The output of the RF oscillator is coupled through capacitor A1A1C12 to buffer amplifier A1A1U1A. The output of the buffer is directly coupled to the RF amplifier A1A1U1B. Two outputs are provided from RF amplifier A1A1U1B. The first is applied to the input of the crystal calibrator circuit, while the second output is coupled to buffer amplifier A1A1U2A. The RF amplifier has a gain of approximately two with RF LEVEL control A1R1 set for maximum resistance. The signal from the wiper arm of A1R1 is coupled through capacitor A1A1C15 to buffer amplifier A1A1U2A. Buffer amplifier A1A1U2A operates as an emitter follower, providing a low impedance output signal.

2. SWEEP CIRCUIT

A sweep signal is formed by repeatedly increasing and decreasing the frequency of an oscillator. The basic frequency of the oscillator, before it is swept, is known as the center frequency. The total amount of frequency variation above and below the center frequency is called the sweep width. The signal is swept back and forth through the band of frequencies a certain number of times per second. This is known as the sweep rate. The sweep rate is 50 or 60 times per second depending on the line frequency. Variable capacitance diode A1A1CR1 is used in conjunction with the 455kHz (A1A1L1, A1C1) and 10.7MHz (A1A1L2, A1C1) tuned circuits to sweep the RF oscillator. Ac voltage is applied to A1A1CR1 from the secondary winding on transformer A1T1 through SWEEP switch S3, potentiometer R9, resistor A1A2R3, capacitor A1A2C7 and resistor A1A2R56 to provide a 50/60Hz sweep rate. Bias voltage for variable capacitance diode A1A1CR1 is established by resistor A1A2R5 and potentiometer A1A2R4. Potentiometer A1A2R4 is made variable to obtain linearity control over the sweep range. The sweep width is made variable with potentiometer R9.

3. CRYSTAL OSCILLATOR

The crystal controlled oscillator is operated by inserting a crystal of the desired frequency into the socket on the front panel of the instrument. The crystal oscillates in parallel resonance, fundamental mode. Positive feedback is from the collector of A1A2U1A to the base of A1A2U1D and then to the base of A1A2U1A. Transistor A1A2U1D, an emitter follower, is placed between the crystal and the base of A1A2U1A. The emitter-follower increases the input impedance seen by the crystal looking into the base of A1A2U1A, which is usually small compared with crystal characteristics. Small changes in frequency can be obtained by varying the 10 to 40 pF trimmer A1A2C10.

4. CRYSTAL CALIBRATOR CIRCUIT

The crystal oscillator output signal, along with the RF oscillator output, are mixed and amplified together by transistor A1A2U1B. Diode A1A2CR8 then rectifies the complex signal, which is coupled through capacitor A1A2C16 to the twin-T bandpass filter and amplifier A1A2U2. This narrow bandpass amplifier, which has a peak gain at 100Hz, filters and amplifies the difference frequency. This signal is coupled to buffer amplifier A1A2U2, which in turn drives the LED DS2. Potentiometer A1A2R21 controls the bias offset at the output applied to the LED.

5. 1kHz OSCILLATOR

The 1kHz oscillator is a Wien bridge audio oscillator circuit consisting of operational amplifier A1A2U3, a phase feedback network (capacitors A1A2C21, A1A2C20 and resistors A1A2R34, A1A2R32), a clamping network (diodes A1A2CR10, A1A2CR11 and resistors A1A2R35, A1A2R36, A1A2R37, A1A2R38) and associated circuit components. Stage gain is controlled by adjusting A1A2R30, thereby varying the distortion of the oscillator. Potentiometer R1 (MOD LEVEL) provides a means for varying the output level of the oscillator. When the MODULATION switch S2 is in the INT position, the 1kHz output signal is fed to the 1KHz OUT jack, the meter circuit and to the base of transistor A1A2U2C.

6. METER CIRCUIT

a) RF Function. The RF output level, present at the input of the ATTENUATOR selectors, is sampled by the Schottky detector diode A2CR1. The dc output of the detector is

supplied to meter switch S4. Potentiometer A1A2R45 controls the dc bias current through Schottky diode. When the meter switch is set for the RF position, the detector voltage is supplied to meter amplifier A1A2U3 and from there to the RF and % modulation meter M1. Potentiometer A1A2R49 adjusts the meter zero while potentiometer A1A2R57 controls the full scale adjustment. The relative input level present at the input of the ATTENUATOR selectors is indicated on meter M1 in decibels.

b) % Modulation Function. The amplitude of the 1kHz signal is sampled by modulation detector A1A2CR12, which provides a dc voltage proportional to the 1kHz signal level. This is applied to meter switch S4. When the meter switch is in the %MOD position, the modulation detector output is switched to meter amplifier A1A2U3 and from there to the RF and % modulation meter M1. Potentiometer A1A2R43 adjusts the meter zero while potentiometer A1A2R55 controls the full scale adjustment. The meter is calibrated to indicate percent modulation relative to the amplitude of the modulating voltage supplied.

7. ATTENUATOR

The five switches which control individual T-attenuators may be used in any combination. The RF oscillator output is coupled through capacitor A1A1C17 to the input of the ATTENUATOR selectors. The output of the attenuator is supplied through capacitor A1C2 to the RF OUT jack. When the output is terminated in a 50 ohm load, the calibrated RF voltage level is determined by the settings of the RF LEVEL control and ATTENUATOR switch settings.

8. POWER SUPPLY

The power supply consists of a full-wave bridge rectifier A1A2CR1 through A1A2CR4 and a filter network consisting of capacitors A1A2C3, A1A2C4 and resistor A1A2R1. The output of the power supply is +12Vdc and -12Vdc referenced to ground. Regulation is provided by Zener diodes A1A2CR5 and A1A2CR6. For 230Vac operation see Note 7 on schematic diagram.

SECTION 6

MAINTENANCE AND CALIBRATION

The Model 780A and Model 980A RF Generators are manufactured and tested to meet exceptionally high standards of performance. It should give many years of trouble-free service without the need for routine maintenance. The unit is carefully calibrated and checked at the factory and, under normal usage, should not require complete calibration. If, due to tampering or replacement of critical, active semiconductor components, one or more functions lose calibration it is advisable to return the unit to the nearest authorized Lab-Volt repair station or to the factory for testing and recalibration. Contact your area Lab-Volt field representative for instructions on returning the unit.

For those with the capability and facilities, the sequence of measurements and adjustments for recalibration is presented. Follow the sequence carefully, and before changing any adjustment note its position so that you can return to it if necessary. Remember, calibration accuracy is only as accurate as your test equipment. Test equipment should have accuracies ten times greater than the required accuracy of adjustment.

A rear view of the RF Generator is shown in *Fig. 4* to assist in locating assemblies, PC boards and components. *Figs. 5* and *6* show the location of components and adjustments on PC boards A1A1 and A1A2, respectively. Components forming a part of attenuator assembly A2 are shown in *Fig. 7*. The electrical location of the components and adjustments is shown in the schematic diagram of *Fig. 8*.

1. PRELIMINARY PROCEDURE

a) Remove the unit from the tunnel or carrying case and orient it for easy access to the adjustments. PC board A1A1 is located inside assembly A1 housing. The bottom cover must be removed from A1 to gain access to the adjustments.

b) Connect the line cord to the power line.

c) Turn on the RF Generator. Allow a 15 minute warmup period.

d) Use an accurate ohmmeter to test the condition of all test leads.

2. BANDS A-F FREQUENCY AND AMPLITUDE

A frequency counter and a high impedance RF voltmeter with a frequency range up to 110MHz are required for these adjustments.

a) Initial Control Settings.

1) Set MODULATION switch to EXT.
2) Set SWEEP switch to OUT.
3) Remove any crystal from XTAL socket.
4) Set all five ATTENUATOR switches to OUT.
5) Rotate BAND switch to band (B).
6) Rotate MOD LEVEL control fully CCW.
7) Adjust RF LEVEL control to mid-position.
8) Terminate RF OUT jack with 50 ohm resistor.

b) Adjustment Procedure.

1) Rotate RF Frequency dial so that 32 mark on middle scale (B)(D) is positioned over panel index line.
2) Connect frequency counter to RF OUT jack.
3) Use hexagonal nylon tuning rod and adjust tuning slug of coil A1A1L4 to display 320kHz on counter.

NOTE: The RF oscillator frequency is affected by whether the bottom access cover on the A1 enclosure is on or off. Therefore, throughout this procedure, each frequency adjustment must first be made with the cover off. Then the cover must be replaced and the change in frequency observed. The cover must be removed again each time and the adjustment repeated to compensate for the frequency change. This must be repeated as required to obtain an accurate frequency adjustment, both at the high end and the low end of each band.

4) Rotate RF Frequency dial so that 100 mark on (B)(D) scale is positioned over index line.
5) Adjust trimmer capacitor A1A1C2 to display 1MHz on counter.
6) Repeat steps (1) through (5) twice. Remove counter.
7) Rotate RF Frequency dial to index at 660kHz mark on (B)(D) scale.
8) Connect RF voltmeter between collector (pin 1) of transistor A1A1U1D and ground. Adjust potentiometer A1A1R34 for 200mV rms indication.
9) Remove RF voltmeter and connect it to RF OUT jack.
10) Adjust RF LEVEL control (A1R1) for 200mV rms indication on RF voltmeter. **Do not change the setting of A1R1 until after all bands have been calibrated.** Remove RF voltmeter.
11) Rotate BAND switch to band (A).
12) Rotate RF Frequency dial so that 10 mark on (A)(C)(E) scale is over index line.
13) Connect frequency counter to RF OUT jack.
14) Adjust tuning slug of coil A1A1L3 to display 100kHz on counter.
15) Rotate RF Frequency dial to index at 32 mark on (A)(C)(E) scale.
16) Adjust trimmer capacitor A1A1C1 to display 320kHz on counter.
17) Repeat steps (12) through (16) twice. Remove counter.
18) Rotate RF Frequency dial to index at 210kHz mark on (A)(C)(E) scale.
19) Connect RF voltmeter to RF OUT jack.
20) Adjust potentiometer A1A1R30 for 200mV rms indication on meter. Remove RF voltmeter.
21) Rotate BAND switch to band (C).
22) Rotate RF Frequency dial to index at 10 mark on (A)(C)(E) scale.
23) Connect frequency counter to RF OUT jack.
24) Adjust tuning slug of coil A1A1L5 to display 1MHz on counter.
25) Rotate RF Frequency dial to index at 32 mark on (A)(C)(E) scale.
26) Adjust trimmer capacitor A1A1C3 to display 3.2MHz on counter.
27) Repeat steps (22) through (26) twice. Remove counter.
28) Rotate RF Frequency dial to index at 2.10MHz mark on (A)(C)(E) scale.
29) Connect RF voltmeter to RF OUT jack.
30) Adjust potentiometer A1A1R28 for 200mV rms indication on meter. Remove RF voltmeter.

31) Rotate BAND switch to band (D).
32) Rotate RF Frequency dial to index at 32 mark on (B)(D) scale.
33) Connect frequency counter to RF OUT jack.
34) Adjust tuning slug of coil A1A1L6 to display 3.2MHz on counter.
35) Rotate RF Frequency dial to index at 100 mark on (B)(D) scale.
36) Adjust trimmer capacitor A1A1C4 to display 10MHz on counter.
37) Repeat steps (32) through (36) twice. Remove counter.
38) Rotate RF Frequency dial to index at 6.6MHz mark on (B)(D) scale.
39) Connect RF voltmeter to RF OUT jack.
40) Adjust potentiometer A1A1R26 for 200mV rms indication on meter. Remove RF voltmeter.
41) Rotate BAND switch to band (E).
42) Rotate RF Frequency dial to index at 10 mark on (A)(C)(E) scale.
43) Connect frequency counter to RF OUT jack.
44) Adjust tuning slug of coil A1A1L7 to display 10MHz on counter.
45) Rotate RF Frequency dial to index at 32 mark on (A)(C)(E) scale.
46) Adjust trimmer capacitor A1A1C5 to display 32MHz on counter.
47) Repeat steps (42) through (46) twice. Remove counter.
48) Rotate RF Frequency dial to index at 21.0MHz mark on (A)(C)(E) scale.
49) Connect RF voltmeter to RF OUT jack.
50) Adjust potentiometer A1A1R32 for 200mV rms indication on meter. Remove RF voltmeter.
51) Rotate BAND switch to band (F).
52) Rotate RF Frequency dial to index at 110 mark on (F) scale.
53) Connect frequency counter to RF OUT jack.
54) Adjust potentiometer A1A1R24 to mid-position.
55) Adjust trimmer capacitor A1A1C6 for maximum frequency display around 110MHz on counter.
56) Adjust potentiometer A1A1R24 for display of 110MHz on counter.
57) Repeat steps (54), (55) and (56) twice.
58) Replace access cover on A1 enclosure and secure it if no further adjustments are to be performed. Leave cover off if sweep frequency adjustments are to be made.

3. SWEEP FREQUENCIES

A frequency counter and a high impedance RF voltmeter with a frequency range up to 10.7MHz, and an electronic VOM are required for these adjustments.

a) Initial Control Settings. Perform initial control settings of paragraph 2a) except rotate BAND switch to 455KHz SWEEP position. Remove bottom access cover from A1 enclosure to gain access to sweep frequency tuning coils.

b) Adjustment Procedure.

1) Connect RF voltmeter to RF OUT jack.
2) Adjust RF LEVEL control for 200mV rms indication on meter. Remove RF voltmeter.
3) Connect electronic VOM between terminal A1A2E19 and ground.
4) Adjust potentiometer A1A2R4 for -4.5Vdc indication on electronic VOM. Remove VOM.
5) Rotate RF Frequency dial to index at 455kHz mark on (B)(D) scale.
6) Connect frequency counter to RF OUT jack.
7) Adjust tuning slug of coil A1A1L1 to display 455kHz on counter.
8) Rotate BAND switch to 10.7MHz SWEEP position.
9) Rotate RF Frequency dial to index at 10.7MHz mark on (A)(C)(E) scale.
10) Adjust tuning slug of coil A1A1L2 to display 10.7MHz on counter. Remove counter.
11) Replace access cover on A1 enclosure and secure it.

4. CRYSTAL OSCILLATOR AND CALIBRATOR

A frequency counter and an oscilloscope with a frequency range up to 10.7MHz, and an electronic VOM are required for these adjustments.

a) Adjustment Procedure.

1) Insert a 10.7MHz crystal into XTAL socket.

2) Connect frequency counter between A1A2E25 and ground.

NOTE: The output impedance at A1A2E25 is approximately 1000 ohms. Be sure the frequency counter used does not load down the crystal oscillator, otherwise the calibration will be inaccurate.

3) Adjust capacitor A1A2C10 to display 10.7MHz on counter. Remove counter.

4) Remove crystal from socket.

5) Connect vertical input of oscilloscope to pin 1 of operational amplifier A1A2U2. Adjust oscilloscope controls for appropriate display.

6) Connect electronic VOM between terminal A1A2E26 and ground.

7) Adjust potentiometer A1A2R21 for 0.5Vdc indication on electronic VOM. Remove VOM.

5. 1kHz OSCILLATOR

An oscilloscope is required for this adjustment.

a) Adjustment Procedure.

1) Adjust MOD LEVEL control for maximum output.

2) Connect oscilloscope vertical input between 1KHz OUT and GND jacks. Adjust oscilloscope controls for 1kHz sweep and convenient amplitude.

3) Set MODULATION switch to INT.

4) Adjust potentiometer A1A2R30 until waveform on oscilloscope displays maximum amplitude with minimum distortion. Disconnect oscilloscope.

6. MODULATION

An RF voltmeter and an oscilloscope with a frequency range up to 210kHz are required for this adjustment.

NOTE: The RF amplitude adjustments of paragraph 2 must be set correctly before this adjustment can be performed. If the RF amplitude adjustments have not been made, perform the applicable steps of paragraph 2 before continuing with this procedure. All RF Generator controls must remain set as they were at the completion of the amplitude adjustments in order to continue with this procedure.

a) Adjustment Procedure.

1) Rotate BAND switch to band (A).

2) Rotate RF Frequency dial to index at 210kHz mark on (A)(C)(E) scale.

3) Adjust MOD LEVEL control for maximum output.

4) Connect RF voltmeter to RF OUT jack.

5) Adjust RF LEVEL control for 200mV rms indication on meter. Remove meter.

6) Connect electronic VOM between terminal A1A2E26 and ground.

7) Adjust potentiometer A1A2R39 until valley points on oscilloscope waveform just touch on horizontal axis. When X is 0, Y will be approximately 6 centimeters.

8) Rotate MOD LEVEL control and verify that modulation can be varied from 0% at minimum setting to 100% at maximum setting. If not, repeat adjustment.

7. METER

An RF voltmeter and an oscilloscope with a frequency range up to 660kHz, and an electronic VOM are required for these adjustments.

a) RF Function.

1) Set RF Generator controls to initial control settings given in paragraph 2a).

2) Rotate RF Frequency dial to index at 660kHz mark on (B)(D) scale.

3) Rotate RF LEVEL control fully CCW.

4) Connect electronic VOM between terminal A1A2E32 and ground.

5) Set %MOD/RF switch to RF position.

6) Adjust potentiometer A1A2R45 for -0.158Vdc on VOM. Remove VOM.

7) Connect RF voltmeter to RF OUT jack.

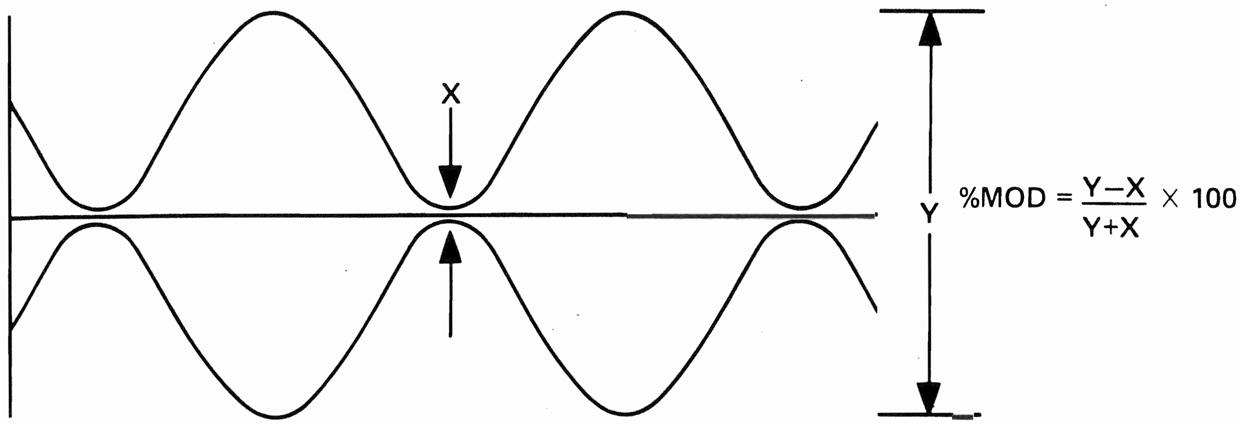
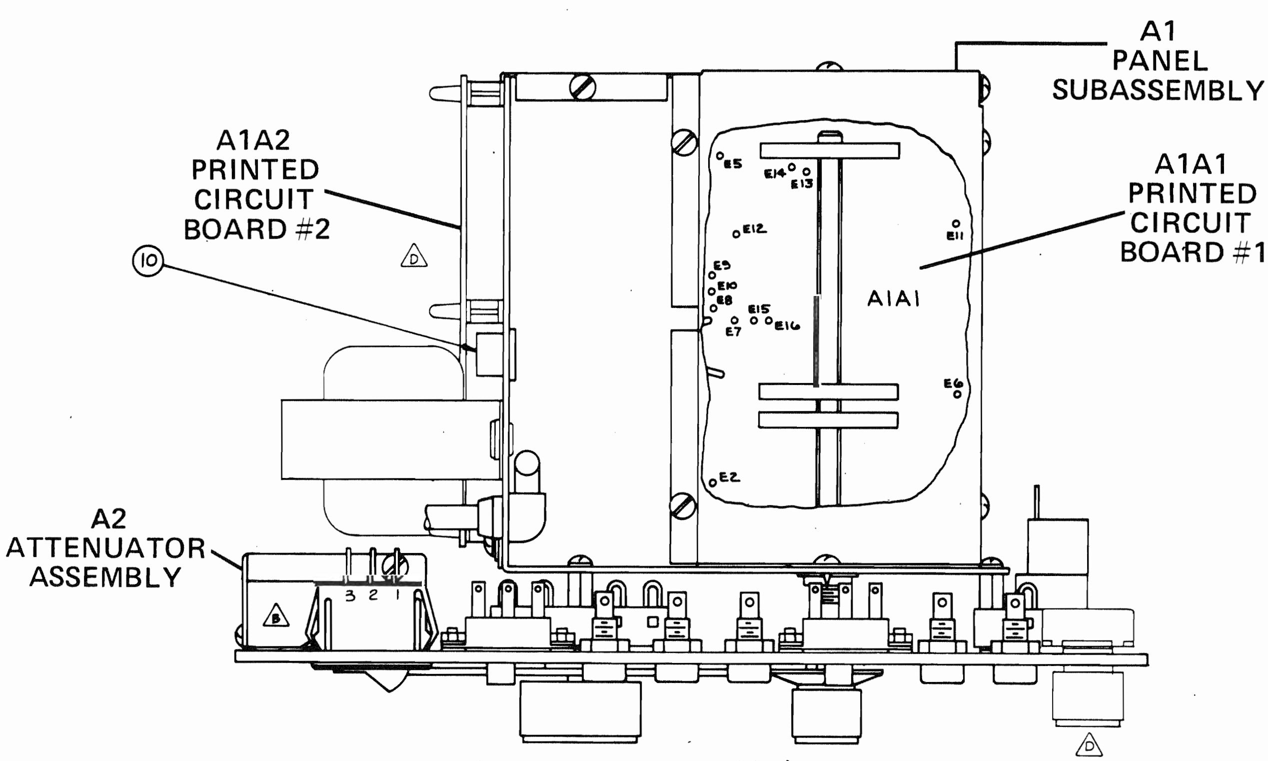


Fig. 3 100% Modulation

8) Adjust RF LEVEL control for 100mV rms indication on RF voltmeter.
9) Adjust potentiometer A1A2R49 for 0db indication on RF Generator Meter M1.
10) Adjust RF LEVEL control for 200mV rms indication on RF voltmeter.
11) Adjust potentiometer A1A2R57 for +6db indication on RF Generator Meter M1.
12) Repeat steps 8, 9, 10 and 11. Remove RF voltmeter.

b) % Mod Function.

1) Rotate BAND switch to band (A).
2) Rotate RF Frequency dial to index at 210kHz mark on (A)(C)(E) scale.
3) Set MODULATION switch to EXT.
4) Connect RF voltmeter to RF OUT jack.



(BOTTOM VIEW 780A)

(Controls and jacks position for Model 980A will vary from those shown in this figure.)

Fig. 4 Assembly and PC Board Locations

5) Adjust RF LEVEL control for 200mV rms indication on RF voltmeter. Remove RF voltmeter.

6) Connect oscilloscope vertical input to RF OUT jack. Adjust horizontal sweep for sinewave and vertical controls for 4cm peak-to-peak defelction.

7) Set MODULATION switch to INT.

8) Adjust MOD LEVEL control for 100% modulation on oscilloscope. A waveform similar to that shown in *Fig. 3* shoud be displayed on oscilloscope.

9) Set MODULATION switch to EXT.

10) Set %MOD/RF switch to %MOD position.

11) Adjust potentiometer A1A2R43 for 0 indication on RF Generator Meter M1.

12) Set MODULATION switch to INT.

13) Adjust potentiometer A1A2R55 for 100% modulation indication on RF Generator Meter M1.

14) Disconnect all test equipment, de-energize the RF Generator and replace it in its tunnel or carrying case.

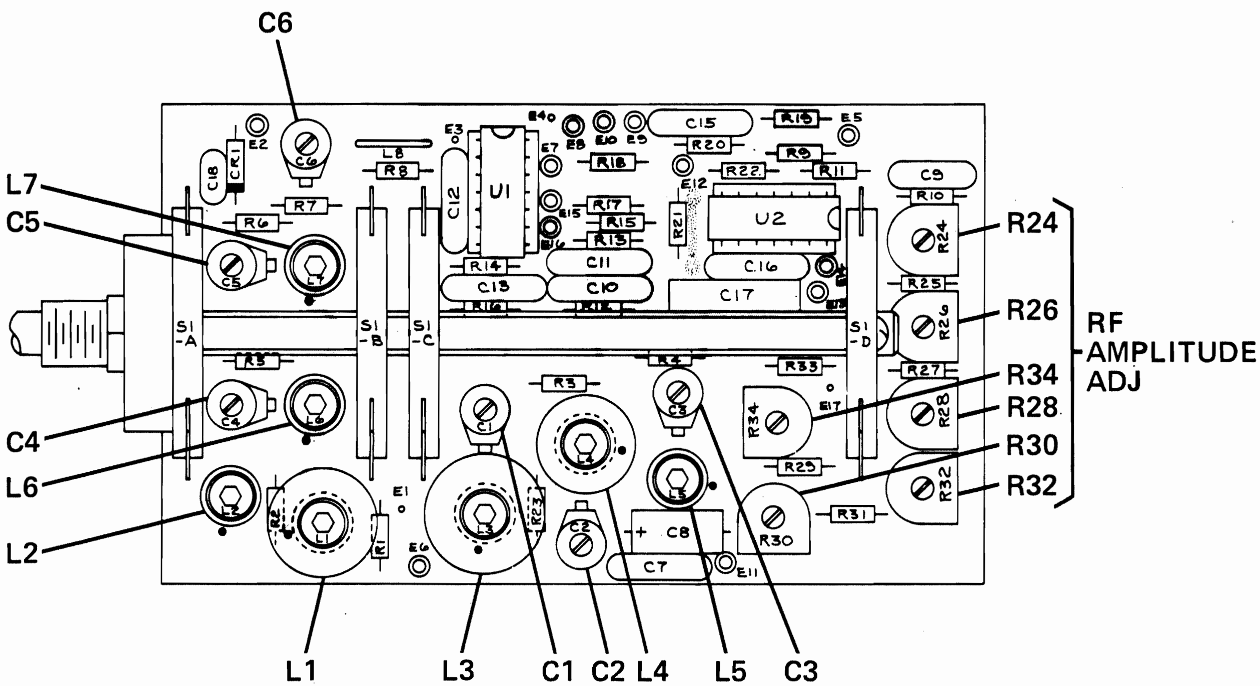


Fig. 5 Printed Circuit Board A1A1, Components and Adjustments

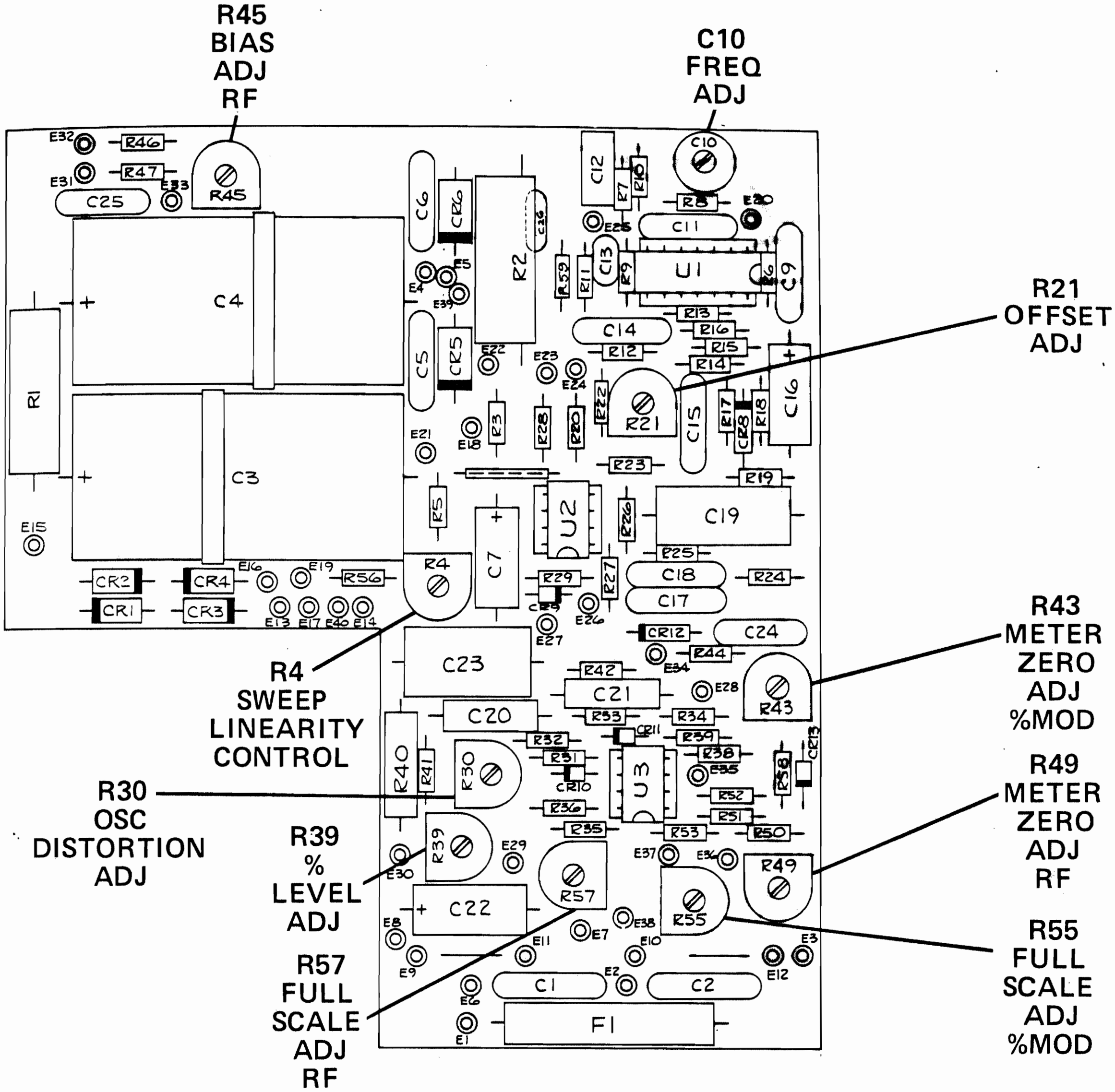


Fig. 6 Printed Circuit Board A1A2, Components and Adjustments

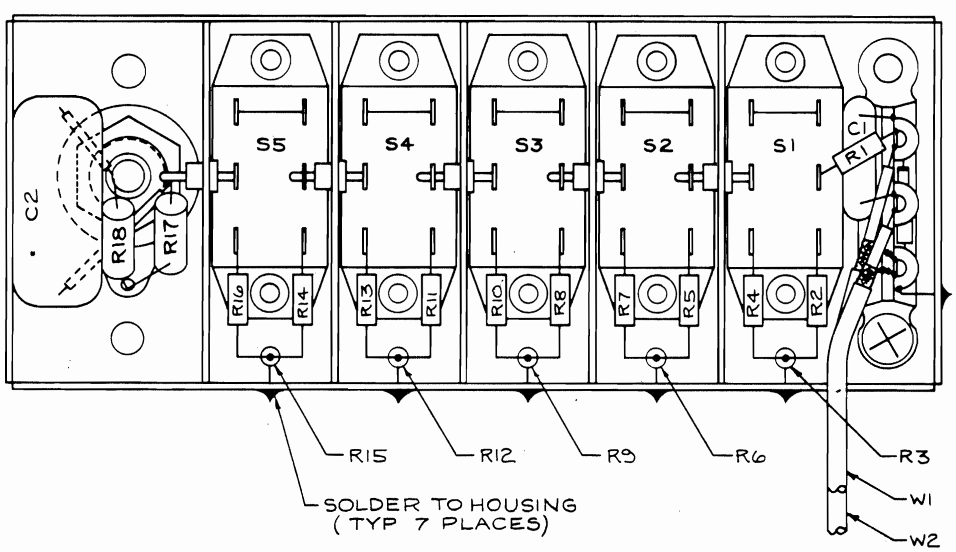


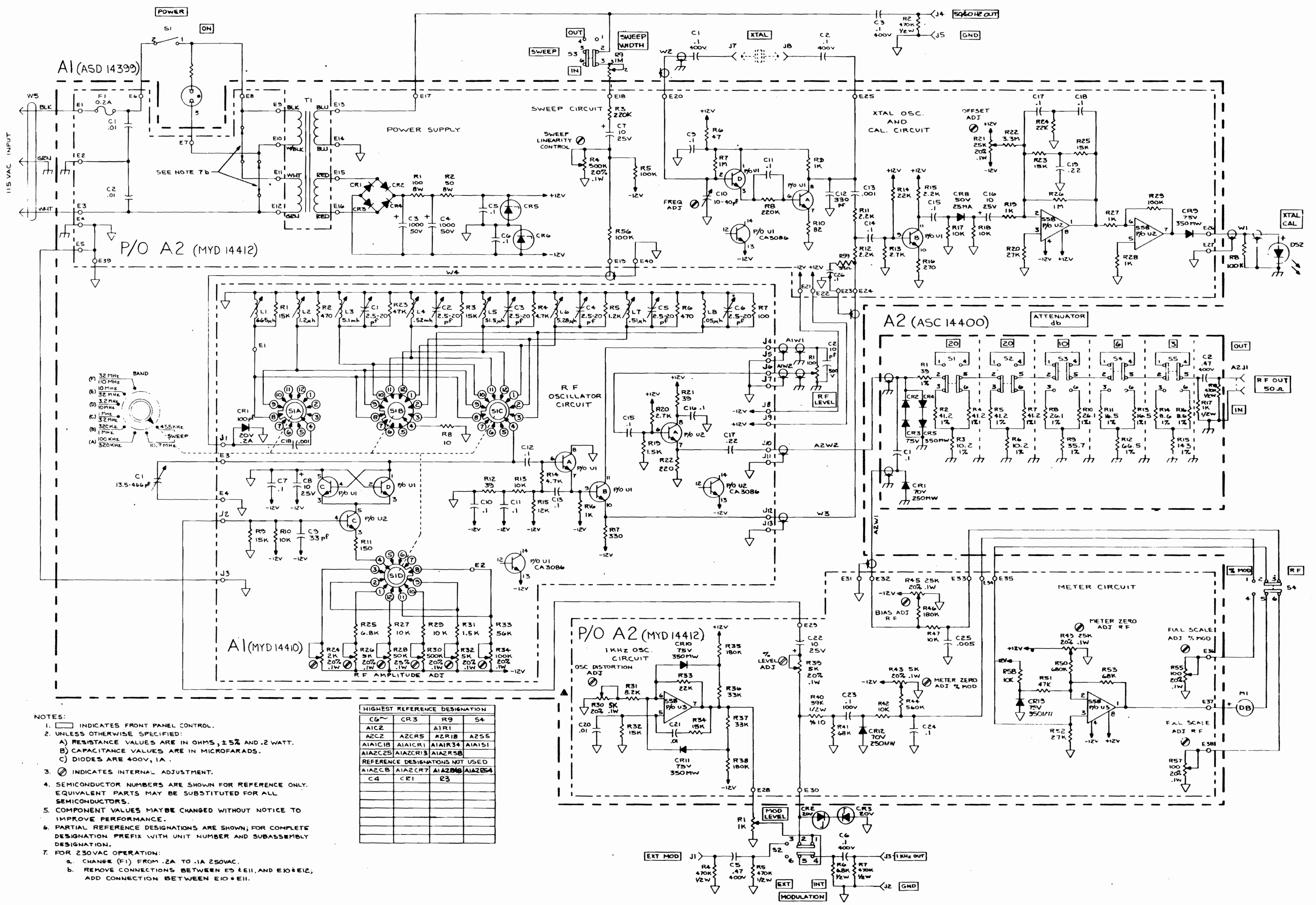
Fig. 7 Attenuator Assembly A2, Components

SECTION 7
REPLACEMENT PARTS LIST

Symbol	Description	P/N
	Chassis Components	
C1	Capacitor, Metalized Polyester, 0.1μF, 400V	KT 14544
C2	Capacitor, Metalized,Polyester, 0.1μF, 400V	KT 14544
C3	Capacitor, Metalized Polyester, 0.1μF, 400V	KT 14544
C5	Capacitor, Metalized Polyester, 0.47μF, 400V	KT 14545
C6	Capacitor, Metalized Polyester, 0.1μF, 400V	KT 14544
CR2	Diode, Zener, 20V, 1W	MD 11722
CR3	Diode, Zener, 20V, 1W	MD 11722
DS2	Indicator, Light Emitting Diode	MR 14612
J1	Jack, Banana, Red	LP 15
J2	Jack, Banana, Black	LP 16
J3	Jack, Banana, Red	LP 15
J4	Jack, Banana, Yellow	LP 17
J5	Jack, Banana, Black	LP 16
J7	Socket, Insulated, 0.050 pin	LP 14398
J8	Socket, Insulated, 0.050 pin	LP 14398
M1	Meter, Split-scale, 100mV, 10Ω	MW 14393
R1	Potentiometer, 1kΩ, 0.5W, 30%	NV 351
R2	Resistor, Carbon Comp, 470kΩ, 0.5W, 5%	NG 14024
R4	Resistor, Carbon Comp, 470kΩ, 0.5W, 5%	NG 14024
R5	Resistor, Carbon Comp, 470kΩ, 0.5W, 5%	NG 14024
R6	Resistor, Deposited Carbon, 6.8kΩ, 0.5W, 10%	NH 11031
R7	Resistor, Carbon Comp, 470kΩ, 0.5W, 5%	NG 14024
R8	Resistor, Deposited Carbon, 100kΩ, 0.2W, 5%	NH 13480
R9	Potentiometer, 1M Ω, 0.5W, 30%	NV 14858
S1	Switch, Rocker, SPST, 15A Light	PH 14623
S2	Switch, Slide, DPDT	PH 12596
S3	Switch, Slide, DPDT	PH 12596
S4	Switch, Slide, DPDT	PH 12596
W1	Cable, Shielded #1	KJ 14598
W2	Cable, Shielded #2	KJ 14599
W3	Cable, Shielded #3	KJ 14600
W4	Cable, Shielded #4	KJ 14601
A1	Panel Subassembly	AS 14399
A1A1	PC Board #1	MY 14410
A1A2	PC Board #2	MY 14412
A1C1	Capacitor, Variable, 0-452ρF	KY 11545
A1C2	Capacitor, Dipped Mica, 10ρF, 500V	KT 12210
A1R1	Potentiometer, 100Ω, 2W, 10%	NV 14592
A1T1	Transformer, Power, Dual Pri/Sec, 33 and 7Vrms, 15VA	QG 14591
A1W1	Cable, Shielded #1	KJ 14594
A1W2	Cable, Shielded #2	KJ 14595
A1A1	Printed Circuit Board #1	MY 14410
A1A1C1	Capacitor, Variable, 2.5-20ρF, 250V	KY 14439
A1A1C2	Capacitor, Variable, 2.5-20ρF, 250V	KY 14439
A1A1C3	Capacitor, Variable, 2.5-20ρF, 250V	KY 14439
A1A1C4	Capacitor, Variable, 2.5-20ρF, 250V	KY 14439
A1A1C5	Capacitor, Variable, 2.5-20ρF, 250V	KY 14439
A1A1C6	Capacitor, Variable, 2.5-20ρF, 250V	KY 14439
A1A1C7	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C8	Capacitor, Electrolytic, 10μF, 25V	KO 556
A1A1C9	Capacitor, Dipped Mica, 33ρF, 500V	KT 13105
A1A1C10	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C11	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C12	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C13	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C15	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C16	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A1C17	Capacitor, Metalized Polyester, 0.22μF, 250V	KT 14543
A1A1C18	Capacitor, Ceramic Disc, 0.001μF, 1000V	KL 561
A1A1CR1	Diode, Varactor, 20V, 0.2A	MD 13977
A1A1L1	Coil, 665μH	LK 14558-01
A1A1L2	Coil, 1.2μH	LK 14558-02
A1A1L3	Coil, 5.16mH	LK 14558-03
A1A1L4	Coil, 528μH	LK 14558-04
A1A1L5	Coil, 51.5μH	LK 14558-05
A1A1L6	Coil, 5.28μH	LK 14558-06
A1A1L7	Coil, 0.515μH	LK 14558-07
A1A1L8	Coil, 0.05μH	XP 406
A1A1R1	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A1R2	Resistor, Deposited Carbon, 470Ω, 0.2W, 5%	NH 13461
A1A1R3	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A1R4	Resistor, Deposited Carbon, 4.7kΩ, 0.2W, 5%	NH 13471
A1A1R5	Resistor, Deposited Carbon, 1.2kΩ, 0.2W, 5%	NH 13465
A1A1R6	Resistor, Deposited Carbon, 470Ω, 0.2W, 5%	NH 13461
A1A1R7	Resistor, Deposited Carbon, 100Ω, 0.2W, 5%	NH 13457
A1A1R8	Resistor, Deposited Carbon, 10Ω, 0.2W, 5%	NH 13491
A1A1R9	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A1R10	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A1R11	Resistor, Deposited Carbon, 150Ω, 0.2W, 5%	NH 13878
A1A1R12	Resistor, Deposited Carbon, 39Ω, 0.2W, 5%	NH 13604
A1A1R13	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A1R14	Resistor, Deposited Carbon, 4.7kΩ, 0.2W, 5%	NH 13471
A1A1R15	Resistor, Deposited Carbon, 12kΩ, 0.2W, 5%	NH 13474
A1A1R16	Resistor, Deposited Carbon, 1kΩ, 0.2W, 5%	NH 13464
A1A1R17	Resistor, Deposited Carbon, 330Ω, 0.2W, 5%	NH 14440
A1A1R19	Resistor, Deposited Carbon, 1kΩ, 0.2W, 5%	NH 13466
A1A1R20	Resistor, Deposited Carbon, 2.7kΩ, 0.2W, 5%	NH 13468
A1A1R21	Resistor, Deposited Carbon, 39Ω, 0.2W, 5%	NH 13604
A1A1R22	Resistor, Deposited Carbon, 220Ω, 0.2W, 5%	NH 13459
A1A1R23	Resistor, Deposited Carbon, 47kΩ, 0.2W, 5%	NH 14357
A1A1R24	Potentiometer, 2k Ω, 0.1W, 20%	NV 11115
A1A1R25	Resistor, Deposited Carbon, 6.8kΩ, 0.2W, 5%	NH 14441
A1A1R26	Potentiometer, 5kΩ, 0.1W, 20%	NV 11094
A1A1R27	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A1R28	Potentiometer, 50kΩ, 0.1W, 25%	NV 11622
A1A1R29	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A1R30	Potentiometer, 500kΩ, 0.1W, 20%	NV 14438
A1A1R31	Resistor, Deposited Carbon, 1.5kΩ, 0.2W, 5%	NH 13466
A1A1R32	Potentiometer, 5kΩ, 0.1W, 20%	NV 11094
A1A1R33	Resistor, Deposited Carbon, 56kΩ, 0.2W, 5%	NH 13478
A1A1R34	Potentiometer, 100kΩ, 0.1W, 20%	NV 12167
A1A1S1	Switch, Rotary, 4 sect, 4 pole, 8 pos, non-shorting	PI 14546
A1A1U1	Integrated Circuit, Transistor/Diode Array, CA3086	MO 13296
A1A1U2	Integrated Circuit, Transistor/Diode Array, CA3086	MO 13296
A1A2	Printed Circuit Board #2	MY 14412
A1A2C1	Capacitor, Ceramic Disc, 0.01μF, 1000V	KL 13502
A1S2C2	Capacitor, Ceramic Disc, 0.01μF, 1000V	KL 13502
A1S2C3	Capacitor, Electrolytic, 1000μF, 50V	KO 11907
A1S2C4	Capacitor, Electrolytic, 1000μF, 50V	KO 11907
A1A2C5	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C6	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C7	Capacitor, Electrolytic, 10μF, 25V	KO 556
A1A2C9	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342

REPLACEMENT PARTS LIST

Symbol	Description	P/N
A1A2C10	Capacitor, Variable, 10-40ρF, 250V	KY 11992
A1A2C11	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C12	Capacitor, Dipped Mica, 330ρF, 500V	KT 11803
A1A2C13	Capacitor, Ceramic Disc, 0.001μF, 1000V	KL 561
A1A2C14	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C15	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C16	Capacitor, Electrolytic, 10μF, 25V	KO 556
A1A2C17	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C18	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C19	Capacitor, Paper Mylar, 0.22μF, 50V	KV 13865
A1A2C20	Capacitor, Paper Mylar, 0.01μF, 100V	KV 13859
A1A2C21	Capacitor, Paper Mylar, 0.01μF, 100V	KV 13859
A1A2C22	Capacitor, Electrolytic, 10μF, 25V	KO 556
A1A2C23	Capacitor, Polyester, 0.1μF, 100V	KT 11105
A1A2C24	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2C25	Capacitor, Ceramic Disc, 0.005μF, 600V	KL 11103
A1A2C26	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A1A2CR1	Diode, Rectifier, 400V, 1A	MD 12068
A1A2CR2	Diode, Rectifier,4	MD 12068
A1A2CR3	Diode, Rectifier, 400V, 1A	MD 12068
A1A2CR4	Diode, Rectifier, 400V, 1A	MD 12068
A1A2CR5	Diode, Zener, 12V, 5W	MD 11996
A1A2CR6	Diode, Zener, 12V, 5W	MD 11996
A1A2CR8	Diode, Rectifier, 50V, 25mA	MD 444
A1A2CR9	Diode, Rectifier, 75V, 350mW	MD 11997
A1A2CR10	Diode, Rectifier, 75V, 350mW	MD 11997
A1A2CR11	Diode, Rectifier, 75V, 350mW	MD 11997
A1A2CR12	Diode, Rectifier, 70V, 250mW	MD 14555
A1A2CR13	Diode, Rectifier, 75V, 350mW	MD 11997
A1A2F1	Fuse, Slow-Blow, 125V, 0.2A	ML 11909
A1A2F1	Fuse, Slow Blow, 250V, 0.1A (AE model)	ML 14418
A1A2R1	Resistor, Wirewound, 100Ω, 8W, 10%	NR 11530
A1A2R2	Resistor, Wirewound, 50Ω, 8W, 5%	NR 11709
A1A2R3	Resistor, Deposited Carbon, 220kΩ, 0.2W, 5%	NH 14356
A1A2R4	Potentiometer, 500kΩ, 0.1W, 20%	NV 14438
A1A2R5	Resistor, Deposited Carbon, 100kΩ, 0.2W, 5%	NH 13480
A1A2R6	Resistor, Deposited Carbon, 47Ω, 0.2W, 5%	NH 13456
A1A2R7	Resistor, Deposited Carbon, 1MΩ, 0.2W, 5%	NH 13483
A1A2R8	Resistor, Deposited Carbon, 220kΩ, 0.2W, 5%	NH 14356
A1A2R9	Resistor, Deposited Carbon, 1kΩ, 0.2W, 5%	NH 13464
A1A2R10	Resistor, Deposited Carbon, 82Ω, 0.2W, 5%	NH 13877
A1A2R11	Resistor, Deposited Carbon, 2.2kΩ, 0.2W, 5%	NH 13467
A1A2R12	Resistor, Deposited Carbon, 2.2kΩ, 0.2W, 5%	NH 13467
A1A2R13	Resistor, Deposited Carbon, 2.7kΩ, 0.2W, 5%	NH 13468
A1A2R14	Resistor, Deposited Carbon, 22kΩ, 0.2W, 5%	NH 13476
A1A2R15	Resistor, Deposited Carbon, 2.2kΩ, 0.2W, 5%	NH 13467
A1A2R16	Resistor, Deposited Carbon, 270Ω, 0.2W, 5%	NH 13460
A1A2R17	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A2R18	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A2R19	Resistor, Deposited Carbon, 1kΩ, 0.2W, 5%	NH 13464
A1A2R20	Resistor, Deposited Carbon, 27kΩ, 0.2W, 5%	NH 13477
A1A2R21	Potentiometer, 25kΩ, 0.1W, 25%	NV 11037
A1A2R22	Resistor, Deposited Carbon, 3.3MΩ, 0.2W, 5%	NH 14431
A1A2R23	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A2R24	Resistor, Deposited Carbon, 22kΩ, 0.2W, 5%	NH 13476
A1A2R25	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A2R26	Resistor, Deposited Carbon, 1MΩ, 0.2W, 5%	NH 13483
A1A2R27	Resistor, Deposited Carbon, 1kΩ, 0.2W, 5%	NH 13464
A1A2R28	Resistor, Deposited Carbon, 1kΩ, 0.2W, 5%	NH 13464
A1A2R29	Resistor, Deposited Carbon, 100kΩ, 0.2W, 5%	NH 13480
A1A2R30	Potentiometer, 5kΩ, 0.1W, 20%	NV 11094
A1A2R31	Resistor, Deposited Carbon, 8.2kΩ, 0.2W, 5%	NH 13472
A1A2R32	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A2R33	Resistor, Deposited Carbon, 22kΩ, 0.2W, 5%	NH 13476
A1A2R34	Resistor, Deposited Carbon, 15kΩ, 0.2W, 5%	NH 13475
A1A2R35	Resistor, Deposited Carbon, 180kΩ, 0.2W, 5%	NH 14432
A1A2R36	Resistor, Deposited Carbon, 33kΩ, 0.2W, 5%	NH 14433
A1A2R37	Resistor, Deposited Carbon, 33kΩ, 0.2W, 5%	NH 14433
A1A2R38	Resistor, Deposited Carbon, 180kΩ, 0.2W, 5%	NH 14432
A1A2R39	Potentiometer, 5kΩ, 0.1W, 20%	NV 11094
A1A2R40	Resistor, Deposited Carbon, 39kΩ, 0.5W, 10%	NH 11028
A1A2R41	Resistor, Deposited Carbon, 68kΩ, 0.2W, 5%	NH 14435
A1A2R42	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A2R43	Potentiometer, 5kΩ, 0.1W, 20%	NV 11094
A1A2R44	Resistor, Deposited Carbon, 560kΩ, 0.2W, 5%	NH 14436
A1A2R45	Potentiometer, 25kΩ, 0.1W, 25%	NV 11037
A1A2R46	Resistor, Deposited Carbon, 180kΩ, 0.2W, 5%	NH 14432
A1A2R47	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A2R49	Potentiometer, 25kΩ, 0.1W, 25%	NV 11037
A1A2R50	Resistor, Deposited Carbon, 680kΩ, 0.2W, 5%	NH 14437
A1A2R51	Resistor, Deposited Carbon, 47kΩ, 0.2W, 5%	NH 14357
A1A2R52	Resistor, Deposited Carbon, 27kΩ, 0.2W, 5%	NH 13477
A1A2R53	Resistor, Deposited Carbon, 68kΩ, 0.2W, 5%	NH 14435
A1A2R55	Potentiometer, 100Ω, 0.1W, 20%	NV 14376
A1A2R56	Resistor, Deposited Carbon, 100kΩ, 0.2W, 5%	NH 13480
A1A2R57	Potentiometer, 100Ω, 0.1W, 20%	NV 14376
A1A2R58	Resistor, Deposited Carbon, 10kΩ, 0.2W, 5%	NH 13473
A1A2R59	Resistor, Deposited Carbon, 39Ω, 0.2W, 5%	NH 13604
A1A2U1	Integrated Circuit, Transistor/Diode Array, CA3086	MO 13296
A1A2U2	Integrated Circuit, Dual Operational Amplifier	MO 13347
A1A2U3	Integrated Circuit, Dual Operational Amplifier	MO 13347
A2	Attenuator Assembly	AS 14400
A2C1	Capacitor, Ceramic Disc, 0.1μF, 50V	KL 14342
A2C2	Capacitor, Metalized Polyester, 0.47μF, 400V	KT 14545
A2CR1	Diode, Rectifier, 70V, 250mW	MD 14555
A2CR2	Diode, Rectifier, 75V, 350mW	MD 11997
A2CR3	Diode, Rectifier, 75V, 350mW	MD 11997
A2CR4	Diode, Rectifier, 75V, 350mW	MD 11997
A2CR5	Diode, Rectifier, 75V, 350mW	MD 11997
A2J1	Jack, Phono, RF	LP 11453
A2R1	Resistor, Deposited Carbon, 39Ω, 0.2W, 5%	NH 13604
A2R2	Resistor, Metal Film, 41.2Ω, 0.2W, 1%	NM 14550
A2R3	Resistor, Metal Film, 10.2Ω, 0.2W, 1%	NM 14442
A2R4	Resistor, Metal Film, 41.2Ω, 0.2W, 1%	NM 14550
A2R5	Resistor, Metal Film, 41.2Ω, 0.2W, 1%	NM 14550
A2R6	Resistor, Metal Film, 10.2Ω, 0.2W, 1%	NM 14442
A2R7	Resistor, Metal Film, 41.2Ω, 0.2W, 1%	NM 14550
A2R8	Resistor, Metal Film, 26.1Ω, 0.2W, 1%	NM 14548
A2R9	Resistor, Metal Film, 35.7Ω, 0.2W, 1%	NM 14549
A2R10	Resistor, Metal Film, 26.1Ω, 0.2W, 1%	NM 14548
A2R11	Resistor, Metal Film, 16.5Ω, 0.2W, 1%	NM 14547
A2R12	Resistor, Metal Film, 66.5Ω, 0.2W, 1%	NM 14551
A2R13	Resistor, Metal Film, 16.5Ω, 0.2W, 1%	NM 14547
A2R14	Resistor, Metal Film, 8.6Ω, 0.2W, 1%	NM 14434
A2R15	Resistor, Metal Film, 143Ω, 0.2W, 1%	NM 14552
A1R16	Resistor, Metal Film, 8.6Ω, 0.2W, 1%	NM 14434
A2R17	Resistor, Carbon Comp, 1kΩ, 0.5W, 5%	NG 11527
A2R18	Resistor, Carbon Comp, 470kΩ, 0.5W, 5%	NG 14024
A2S1	Switch, Slide, DPDT	PH 12596-1
A2S2	Switch, Slide, DPDT	PH 12596-1
A2S3	Switch, Slide, DPDT	PH 12596-1
A2S4	Switch, Slide, DPDT	PH 12596-1
A2S5	Switch, Slide, DPDT	PH 12596-1
A2W1	Cable, Shielded #1	KJ 14556
A2W2	Cable, Shielded #2	KJ 14557
	Lead Set, Phono/gator	KJ 14609
	Lead Set, Banana/gator	KJ 1031
	Line Cord 72"	KJ 11083
	Dial, RF Gen	FP 14395-1
	Knob, 0.71 Dia	FP 11741-3
	Knob, Skt	FP 11740
	Knob, 1.26 Dia	FP 11432



NOTES:

1. ▭ INDICATES FRONT PANEL CONTROL.
2. UNLESS OTHERWISE SPECIFIED:
   A) RESISTANCE VALUES ARE IN OHMS, ±5% AND .2 WATT.
   B) CAPACITANCE VALUES ARE IN MICROFARADS.
   C) DIODES ARE 400V, 1A.
3. ⊘ INDICATES INTERNAL ADJUSTMENT.
4. SEMICONDUCTOR NUMBERS ARE SHOWN FOR REFERENCE ONLY. EQUIVALENT PARTS MAY BE SUBSTITUTED FOR ALL SEMICONDUCTORS.
5. COMPONENT VALUES MAYBE CHANGED WITHOUT NOTICE TO IMPROVE PERFORMANCE.
6. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND SUBASSEMBLY DESIGNATION.
7. FOR 230VAC OPERATION:
   a. CHANGE (F1) FROM .2A TO .1A 250VAC.
   b. REMOVE CONNECTIONS BETWEEN E9 & E11, AND E10 & E12; ADD CONNECTION BETWEEN E10 & E11.

HIGHEST REFERENCE DESIGNATION			
C6~	CR3	R9	S4
A1C2		A1R1	
A2C2	A2CR5	A2R18	A2S5
A1A1C18	A1A1CR1	A1A1R34	A1A1S1
A1A2C25	A1A2CR13	A1A2R58	
REFERENCE DESIGNATIONS NOT USED			
A1A2C8	A1A2CR7	A1A2R48	A1A2R54
C4	CE1	R3	

Figure 8. Schematic Diagram.

14604-D0

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